Comparison of Full- and Half-Dose Gadolinium-DTPA: MR Imaging of the Normal Sella

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PURPOSE: This study compares sellar intensities in 17 patients without sellar pathology using half (0.05 mmol/kg, nine patients) and full-dose (0.1 mmol/kg, eight patients) gadopentetate dimeglumine (Gd-DTPA). METHODS: Sellar MR studies of eight patients who received full and nine patients who received half-dose Gd-DTPA were compared, retrospectively. Sequences included pre-, immediate, and delayed postcontrast T1-weighted coronal images (1.5 T). Intensity measurements were obtained by two observers using a uniform region of interest. RESULTS: Comparison of normalized intensities revealed no significant difference between intensities obtained from immediate half- and full-dose techniques for any of the tissues examined (Student’s t test, P < .90). Delayed scans likewise demonstrated no significant intensity differences between full- and half-dose studies. CONCLUSION: Our findings suggest that a 50% reduction in dosage of Gd-DTPA for sellar MR at 1.5 T results in no significant diminution in intensity of enhancement of the pituitary gland or adjacent tissues.

Index terms: Sella turcica, magnetic resonance; Pituitary gland, magnetic resonance; Contrast media, paramagnetic

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Gadopentetate dimeglumine (Gd-DTPA, Berlex, Wayne, NJ), a paramagnetic contrast agent for use in magnetic resonance (MR) imaging, has rapidly gained acceptance for the investigation of pituitary and sellar pathology (1–9). The recommended dose of Gd-DTPA for most intracranial pathology is 0.1 mmol/kg (10, 11). The optimum dosage for sellar imaging, however, has not been studied in detail. A recent preliminary study of pituitary adenoma reported that no recognizable loss of sensitivity for lesion detection occurred with a 50% reduction of the usual dose of Gd-DTPA in MR imaging of the sella (12). The reduction to half of the usual dose was chosen arbitrarily, although this dose has been evaluated previously as an alternative for a variety of intracranial pathologies (13). The effect of this dose reduction on the intensity of normal sellar and parasellar structures has not been clearly documented. This study compares objectively the differences in intensities of sellar and parasellar tissues using full- (0.1 mmol/kg) and half-dose (0.05 mmol/kg) Gd-DTPA for sellar MR imaging in patients with no demonstrable central nervous system (CNS) or sellar pathology.

Materials and Methods

A retrospective review of MR reports from our institution beginning in 1988 was performed to identify patients with normal Gd-DTPA-enhanced MR studies of the sella. A full dose of Gd-DTPA was used at our institution prior to March 1989. Since March 1989, all paramagnetic contrast-enhanced MR examinations of the pituitary gland at our institution have been performed using a half dose of Gd-DTPA. The 50% reduction was chosen arbitrarily. It was felt that a reduced dose was visually advantageous in evaluation of the pituitary gland and adjacent cavernous sinus. A recent report described success using a 50% reduction of Gd-DTPA for sellar imaging of pituitary adenoma (12).

All patients had been referred specifically for evaluation of suspected sellar/parasellar abnormalities, and scans
were tailored accordingly. Patients with reports indicating questionable abnormalities, gland enlargement without focality, prior or subsequent sellar surgery, parasellar or suprasellar masses, motion artifacts, incomplete studies, and those with no visible evidence of Gd-DTPA enhancement of normal tissues were excluded. From this group, 17 patients with normal MR examinations and similar scanning parameters were selected for image analysis. This group consisted of eight patients who received full-dose Gd-DTPA (0.1 mmol/kg) and nine patients who received half-dose Gd-DTPA (0.05 mmol/kg). Follow-up as of April 1991 (26–29 months since this group of MR studies), indicated that none of these patients had subsequently undergone sellar exploration or had an abnormal sellar MR or computed tomography (CT) examination at our institution.

All MR examinations were performed on a 1.5-T MR imaging unit. Scan protocol consisted of sagittal scout and coronal noncontrast T1-weighted multisection sequences using 2.5-mm section thickness and 0.5-mm intersection gap (500–700/20/4) (TR/TE/excitations). Following intravenous administration of Gd-DTPA and an appropriate volume (approximately 10 mL) of isotonic saline solution to clear the intravenous tubing of residual contrast, immediate and delayed postcontrast coronal images were obtained using identical scanning parameters. All delayed images were completed 9–30 minutes postcontrast injection. For detailed image analysis, all MR studies were retrieved from optical disk storage and reviewed on an independent console. After image magnification, sellar and parasellar intensities were measured and recorded from precontrast, immediate, and delayed postcontrast images.

Intensities were measured using uniformly sized and positioned region of interest (ROI) techniques. All measurements were obtained by two observers (A.R.G., G.J.J.). The tissue sample size and configuration for ROI measurements were held constant for all measurements, although the actual shape and size of the ROI varied in a predetermined fashion from tissue to tissue depending on the size and shape of the region being evaluated. To ensure consistency in sampling location, the precontrast studies were evaluated by measuring average tissue intensity in at least three separate areas within a given tissue. The area rendering maximum intensity was chosen and subsequent postcontrast measurements were obtained from an identical (or nearly identical) location. Tissues evaluated included temporal gray matter (Gy) and white matter, pterygoid muscle, nasopharyngeal mucosa, cavernous sinus, anterior lobe of pituitary, infundibulum, posterior lobe of pituitary, and cerebrospinal fluid (CSF). These values were then normalized to both precontrast MR intensities and CSF intensities. Statistical analysis was performed. Two different approaches were used to compare the results of tissue intensities in these patients. The first approach consisted of determining the mean signal intensity for each tissue on noncontrast sequences in each population sample; these values were then used to normalize the two sets of tissues for comparison purposes. The second approach consisted of normalizing each subject’s individual tissue intensity measurements to the CSF intensity measurement for that subject. In both instances, a two-tailed Student’s t-test was used to evaluate significance of differences between the two sets of tissue values.

**Results**

Comparison sellar MR images using full- and half-dose precontrast, immediate, and delayed postcontrast techniques are demonstrated using similar window and level settings (Figs. 1 and 2). There were no consistent differences apparent on visual comparison of full- and half-dose studies.

Mean signal intensities for each tissue in each population sample were determined. The data revealed the mean half-dose intensities on pre- and postcontrast images to be more intense than the mean full-dose intensities because of an overall improvement in signal. Because there was almost a year’s difference between the two pop-
ulation samples, it is likely that equipment improvements accounted for this overall increase in signal intensity.

To correct for these technical differences in signal intensity between the two populations, two different normalization approaches were used. The first approach consisted of determining the mean signal intensity on precontrast sequences for tissues in each population sample; these values were then used to normalize the postcontrast tissue intensities for comparison purposes. Comparison of normalized intensities using this approach is depicted in Figures 3 and 4. There was no significant difference between intensities obtained from immediate half- and full-dose techniques for any of the tissues examined (Student's $t$-test, $P < .95$), i.e., a 95% probability that these groups are the same. Delayed scans (9–30 minutes) likewise demonstrated no significant intensity difference between full and half dose studies.

The second approach consisted of normalizing each measured tissue intensity to the CSF intensity measured for that individual. Subsequently, the mean intensity values for each tissue obtained from normalized data were compared on pre-, immediate, and delayed postcontrast studies. There was no significant difference using this approach between the intensities obtained from the half- and full-dose techniques on the immediate or delayed sequences (Student's $t$-test, $P < .95$).

Discussion

The current recommended dose for contrast-enhanced MR imaging of CNS pathology is 0.1 mmol/kg. This recommended dose is based on optimization of MR imaging for a wide variety of intra- and extra-axial CNS pathologies (10, 11).

Overall, the data to date addressing use of reduced doses of paramagnetic contrast for other CNS applications has been disappointing. Indeed, some studies suggest that higher doses (>0.1 mmol/kg) may be preferable for certain CNS pathologies, such as detection of cerebral metastases (13). Potential disadvantages of higher doses, however, include contrast cost, toxicity, renal excretion, and hemolysis. Safety and efficacy of routine doses have been evaluated (14); however, higher doses have not yet been extensively studied in humans for these parameters.
physician should view sellar MR studies at the imaging console with varying window and level settings to improve the conspicuity of small sellar lesions. This raises the possibility that the marked sellar enhancement, perhaps in combination with section thickness limitations (2.5 mm) and volume averaging, may detract from or even obscure rather than optimize detection of small lesions. In addition, our experience is that routine full-dose sellar MR studies result in poor definition of the medial cavernous sinus apart from the lateral pituitary gland.

A small series of sellar MR studies in patients with pituitary adenomas performed with half-dose Gd-DTPA demonstrated equivalent sensitivity when correlated with surgical findings to that of previously reported series using full-dose techniques (12). The assumption that prompted further testing of a reduced dose of contrast was that a visible and measurable reduction in intensity of sellar enhancement would result. Our results in this study, however, indicate no visible or measurable effect of the reduced dose on measured intensities of sellar tissues; thus, our findings did not support the anticipated advantage of a reduction using half-dose techniques in the overly intense sellar enhancement of full-dose studies. This unexpected result leads us to question whether even smaller doses might be preferable. Smaller doses would necessitate precise administration techniques with careful clearing or flushing of the intravenous tubing after contrast administration to assure that the dose administered is actually delivered to the patient, as has been described in use of small doses in children (17).

The effects of half-dose techniques in this study were evaluated only in reference to sequences using relatively short echo times and spin-echo techniques. Further study is required before this lower dose can be recommended for lesser field strength magnets or those using longer echo times that might affect sensitivity to T1 shortening. Likewise, optimum or minimum contrast doses required for use with other sequences such as 3-D gradient echo or very short echo time sequences (ie, <10 msec) have not been established.

Another area of concern in application of reduced dose techniques is the patient clinically suspected of sellar pathology who instead has a supra- or parasellar mass. Many of these lesions that clinically might mimic an intrasellar lesion are outside the blood-brain barrier (ie, neurofibroma, meningioma); in our experience, lesion...
identification and extent are not significantly affected by inadvertent MR examination of these lesions with half-dose techniques. More worrisome is the potential diminution in enhancement with half-dose techniques of an intraaxial mass in this region (ie, hypothalamic or chiasmal glioma). In our experience, these intraaxial parasellar masses are adequately visualized on half-dose scans. In the event that an intraaxial mass did enhance poorly on a half-dose study, a repeat injection with a second half dose of paramagnetic contrast could be considered without exceeding the currently recommended dosage of Gd-DTPA.

In summary, our study found that a 50% reduction in Gd-DTPA dosage for sellar MR at 1.5 T resulted in no significant diminution in enhancement visually or based on intensity measurements of the normal pituitary gland or adjacent parasellar tissues. Our findings support use of this lesser dose of contrast as a reasonable alternative for sellar MR studies, with the primary advantage being reduced contrast cost. Whether these contrast recommendations are optimum for MR examinations using other field strengths of pulse sequences, and whether similar dose reductions are an acceptable alternative using other paramagnetic contrast agents require further study.

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References


